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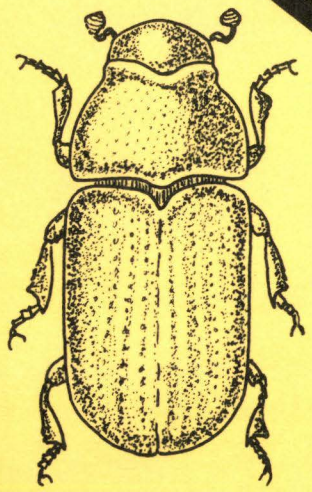

Southwestern Region

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MT. BALDY SPRUCE BEETLE BIOLOGICAL EVALUATION

Population Trend, Stand Structure, and Tree Resource Losses

Fort Apache Indian Reservation, Arizona

1971

Branch of Forest Insect and Disease Management
Division of Timber Management
Southwestern Region, USDA, Forest Service
Albuquerque, New Mexico 87101

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ABSTRACT

Spruce beetle populations continued to decline on the Fort Apache Indian Reservation. Timber resource losses were lower than previously predicted. Only 4% of the host trees within the 15,660 cruised acres has been lost since the initial outbreak began, representing a loss of 46.5MMBF or 12.2% of the merchantable spruce resource within the cruised area. Stand susceptibility and timber resource losses by diameter classes were obtained for the first time in Region 3. Nearly 75% of the cruised spruce was 6-14 inches in d.b.h., indicating that this may not be an overmature stand. Although the larger trees may be the preferred host, the beetle was not as selective as previously thought. Mortality was highest in the 12-inch diameter class, with 12.66% of the total tree mortality. The scattered and concentrated blowdown that occurred in late October 1971 is of concern. What influence it will have on the population is speculative at this time. The accessible blowdown should be used wherever possible as trap trees by removing after August 15, 1972.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
HISTORY	1
METHODS	2
RESULTS	3
DISCUSSION	13
RECOMMENDATIONS	15
LITERATURE CITED	16
APPENDIXES	17

INTRODUCTION

The spruce beetle, Dendroctonus rufipennis (Kirby), has been at epidemic levels in the spruce stands on the Fort Apache Indian Reservation and Apache National Forest, Arizona, since 1968. The gross Reservation acreage occupied by Engelmann spruce (Picea engelmannii Parry) and corkbark fir (Abies lasiocarpa var. arizonica (Merr.) Lemm.) is 41,000. Another 20,000 acres is currently stocked with quaking aspen (Populus tremuloides Michx.). The net volume of spruce within the Reservation before beetle losses was 696MBF.

A biological evaluation conducted in five of the major drainages on the Reservation, during the summer and fall of 1971, is reported. The evaluation was designed to gain information on forest stand structure, effect of the infestation upon the timber resource, and current beetle population potential. Criteria for selection of drainages to be evaluated were based upon logging operability and the probability of a significant pest control accomplishment, should suppression be recommended. Wilderness and inoperable areas were not evaluated, but observations showed the pattern to be the same throughout the infestation.

HISTORY

The spruce stands within the Reservation have a long history of spruce beetle activity. From 1948 to 1951, 2,500 acres were infested before the population dropped out because of unknown reasons. An endemic population existed until 1967 when 74 larvae/ft^2 were found in logging slash in the Coulter Sale Unit in Becker Creek (Germain 1967). The same biological evaluation showed that logging slash and blowdown in Diamond Creek contained 48 larvae/ft^2. A second evaluation made in the fall of 1969 indicated a sharply increasing beetle population (Lucht 1969). An estimated 50+ larvae/ft^2 were found in standing trees in Reservation and Smith Creek drainages. Aerial photography showed infested areas in Bonito, Becker, and Paradise Creek drainages. Salvage logging and a green trap-tree program was recommended for Reservation Creek (Lucht 1969). Salvage logging in Reservation Creek was finished in 1971.

The first presuppression survey was made in the fall of 1969 in Reservation and Becker Creeks.[1/] [2/] A second survey in the summer

1/ Ground survey report, Engelmann spruce beetle infestation, Reservation Creek Area, Fort Apache Indian Reservation, Arizona. 1969. 4 p.
2/ Ground survey report, Engelmann spruce beetle infestation, Becker Creek Area, Fort Apache Indian Reservation, Arizona. 1969. 1 p.

of 1970 was conducted in the seven major drainages.3/ The surveys showed further worsening of the epidemic, and prescriptions to contain the infestation in 1971 were recommended.

During the week of January 1, 1971, record low temperatures occurred in the Southwest, which reduced the beetle population (Frye 1971). The official low for Hawley Lake, which borders the infested area, was -40° F. The sudden drop in temperature resulted in an 87.6% reduction in the larval population in Becker, Ord, Paradise, Reservation, and Smith Creek drainages.4/ The low temperatures did not appear to harm the parasite-predator complex. The below normal snow depth offered little protection to the beetles in the lower bole. None of the drainages had a larval population high enough to be considered treatable.

With the downward trend of the beetle population and salvage operations within the catastrophic fire-damaged areas, no suppression action was directed toward the pest in 1971.

METHODS

Cruise Data.--This evaluation was made by Region 3 Forest Service Pest Control personnel during the summer and fall of 1971. A total of 15,660 acres were cruised: 2,985 in Diamond Creek, 4,685 in Ord Creek, 4,540 in Paradise Creek, 2,755 in Smith Creek, and 695 in Reservation Creek.

Plots were on 5-chain intervals along cruise lines, and the cruise lines were 10 chains apart. The variable plot method was used with a 20-basal-area factor. Critical angles were measured with a Spiegel-Relaskop. Trees occurring in each plot were tallied as to species and d.b.h. in 2-inch diameter classes beginning with 6 inches.5/ Spruce trees were then tallied according to year attacked by the spruce beetle, or as live. Because of the difficulty in separating trees which were attacked in 1970 from older-attack trees, these two categories were grouped into trees infested prior to 1971. The survey coordinate lines and cruise lines were the same as used in past surveys, with the

3/ Presuppression survey report, spruce beetle infestation, Fort Apache Indian Reservation, Arizona. 1970. 12 p.
4/ Supplemental biological evaluation for spruce beetle winter mortality, Fort Apache Indian Reservation, Arizona. 1971. 4 p.
5/ 5.0 to 6.9 inches d.b.h. = 6-inch diameter class; 7.0 to 8.9 inches = 8-inch diameter class, etc.

exception that lines out of host type species were dropped. Reservation Creek cruise data consisted of only the area around the cutting blocks. The cruise data were analyzed using a program called NSEC, written by Robert E. Green (ADP, R-4, 1971), for use by Region 4 entomologists. The program was modified to meet our needs by Don J. Horton (ADP, R-3).

The ADP print-out overlay maps were used to summarize cruise plot data. The top number on each cruise line represented the number of live spruce trees with a d.b.h. of 15 inches or more. The middle and bottom lines represented the number of trees killed by the spruce beetle in 1971 and prior to 1971, respectively. Every tenth plot was marked by an "X".

Infestation Trend.--Bark samples were collected in September 1971 from Diamond, Ord, Paradise, and Reservation Creek drainages. A minimum of 11 trees were selected in a pocket of infested trees, and an approximate 6X6-inch bark and wood sample was removed from the north and south sides of each tree at breast height with a chain saw. The samples were brought to Albuquerque for examination. The number of beetles, attacks, and egg gallery length were counted and converted to number/0.25 ft^2 (6X6-in.). The number of live adults were then compared to those in Knight's (1960) sequential sample plan to determine the population trend.

RESULTS

Cruise Data.--Stand Data. Engelmann spruce was the primary component in all drainages. True fir, Douglas-fir, and aspen were minor components. Stand structure by species in terms of trees and basal area (b.a.)/acre are compared in Figures 1 and 2.

Diamond Creek was the least stocked and Paradise Creek was the highest stocked drainage in both trees and basal area/acre (Tables 1 and 2). This was the case for both spruce and all species of trees. Total trees/acre for all species ranged from 209.72 (b.a. = 180.4) in Diamond Creek to 239.58 (b.a. = 226.28) in Paradise Creek. Spruce trees/acre ranged from a low of 116.64 (b.a. = 117.52) in Diamond Creek to a high of 185.14 (b.a. = 185.14) in Paradise Creek.

The spruce consisted primarily of small trees, with the dominant diameter classes being 14 inches d.b.h. or less (Figure 3). Seventy-one (71) percent (Smith and Paradise) to 78% (Ord) fell into these diameter classes. Overall, 73.4% of the spruce in the cruised area was in the 6-14 inches diameter classes, and only 5.24% was greater than 22.9 inches in d.b.h. (Table 3).

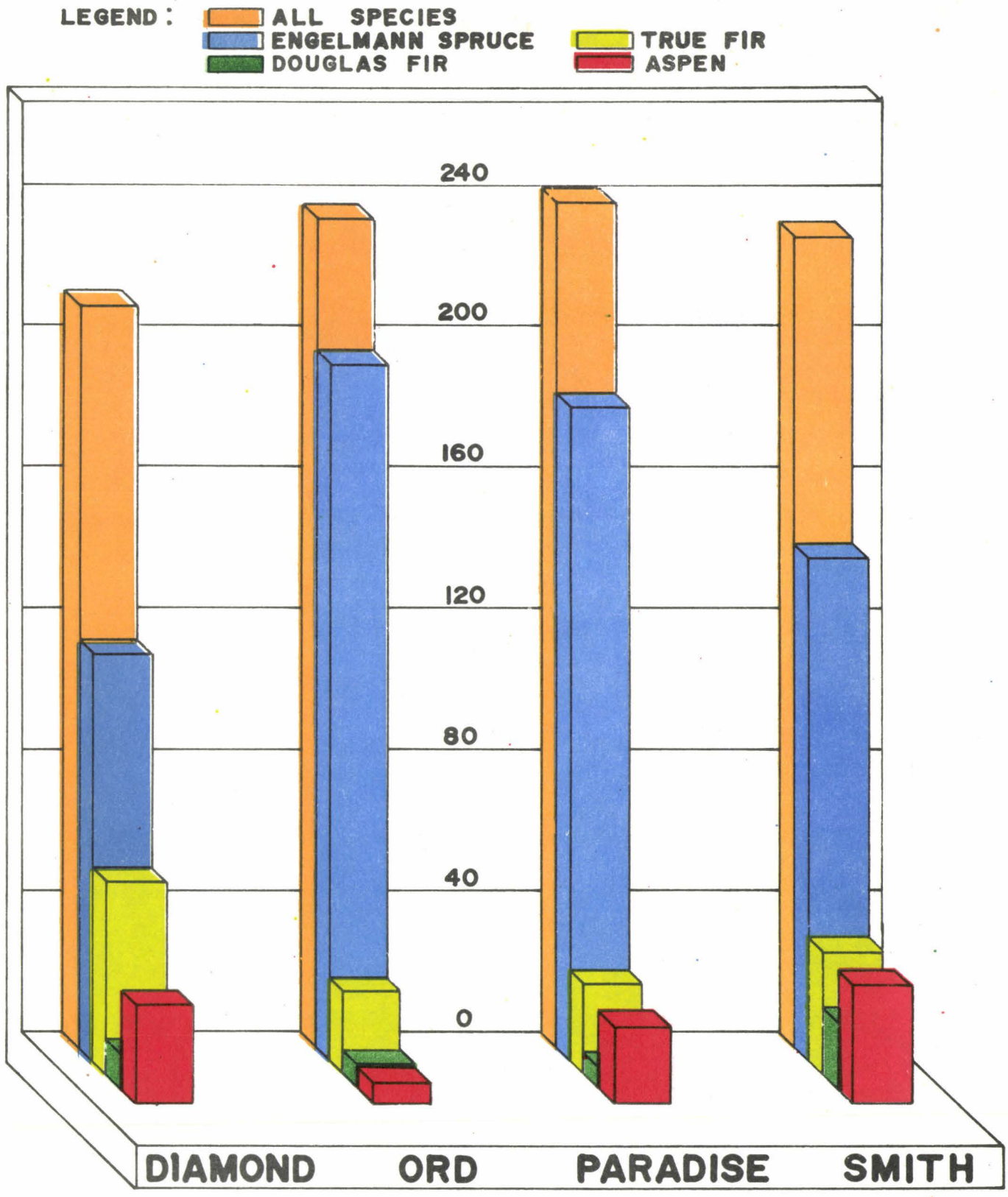


Fig. 1.— Trees per acre for host and non-host trees.

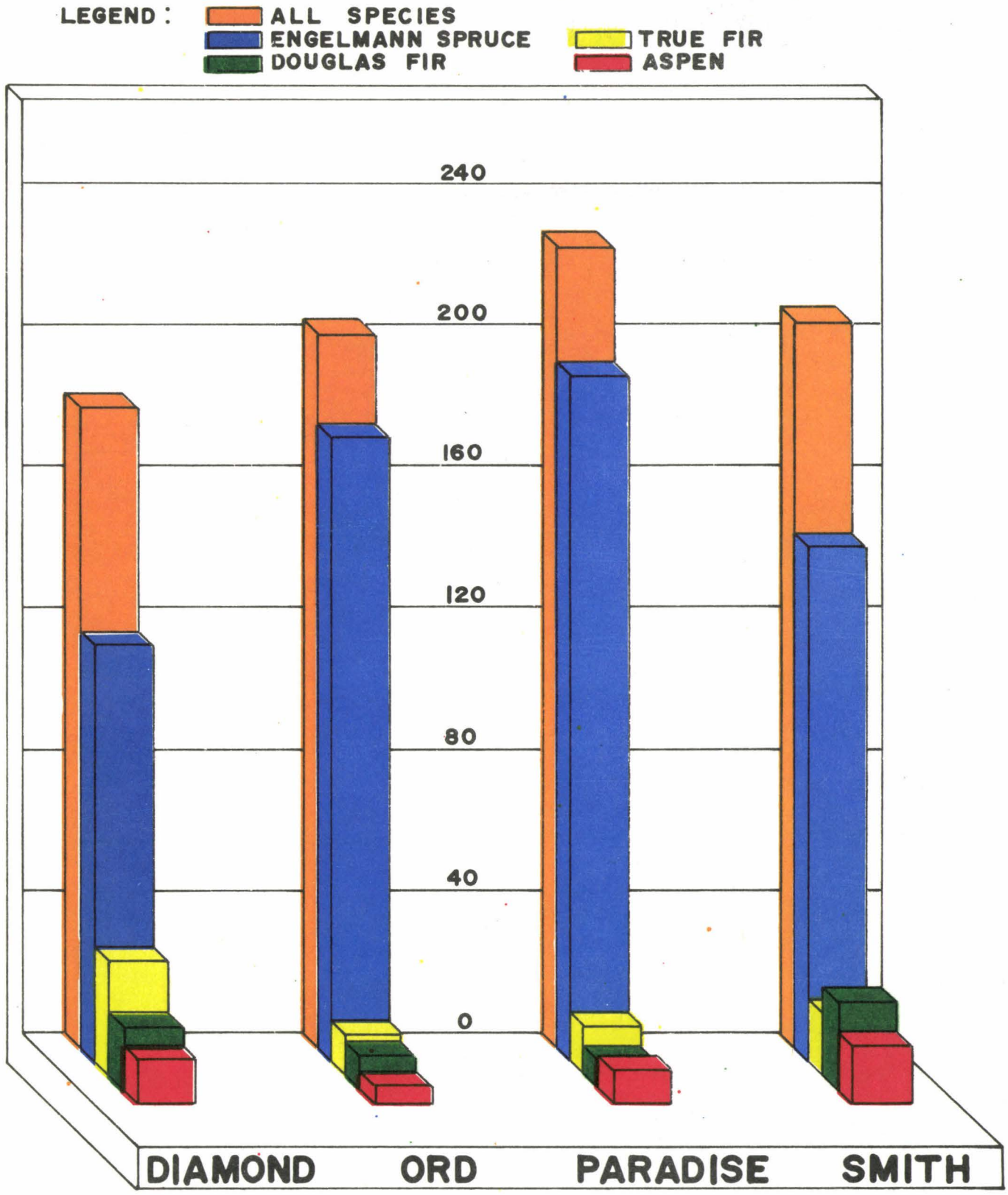


Fig. 2.—Basal area per acre for host and non-host trees.

Table 1.--Trees per acre for host and non-host trees.

	Trees/acre											
	Engelmann spruce											
Drainage	Live	'71 I/T[a/]	Pre '71 I/T[b/]	Total	Total dead	% dead	Douglas-fir	True fir	Aspen	Total	Total for all species	% spruce
Diamond	111.64	0.7 ± .34	3.66	116.0	4.36	3.76	10.12	55.19	28.42	93.73	209.72	55.25
Ord	190.65	1.98± .64	4.85	197.48	6.83	3.45	6.91	23.49	6.18	36.58	234.06	84.37
Paradise	175.68	4.16± .99	5.3	185.14	9.46	5.12	5.8	25.92	22.92	54.44	239.58	77.28
Smith	133.74	1.77± .62	6.93	142.44	8.7	6.1	18.73	35.25	33.42	87.40	229.84	61.97
Reservation	62.08	0.24± .27	4.8	67.11	5.04	7.5	3.27	59.53	7.19	69.99	137.1	48.94

a/ Trees infested with spruce beetles in 1971.
b/ Trees infested with spruce beetles prior to 1971.

Table 2.--Basal area per acre for host and non-host trees.

Drainage	Engelmann spruce basal area/acre						Basal area/acre					
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total	Total dead	% dead	Douglas-fir	True fir	Aspen	Total	Total for all species	% spruce
Diamond	108.48	1.17	7.87	117.52	9.04	7.69	17.42	32.56	12.9	62.88	180.4	65.14
Ord	165.05	2.79	8.51	176.35	11.3	6.85	9.6	11.49	4.79	25.88	202.24	87.20
Paradise	174.47	6.44	12.82	193.73	19.26	9.94	9.12	13.82	9.61	32.55	226.28	85.62
Smith	130.57	3.2	11.9	145.68	15.1	10.36	25.36	18.14	16.65	60.15	205.83	70.78
Reservation	51.69	0.62	9.5	61.81	10.12	16.37	6.67	34.67	8.67	50.0	111.81	55.28

a/ Trees infested with spruce beetles in 1971.
b/ Trees infested with spruce beetles prior to 1971.

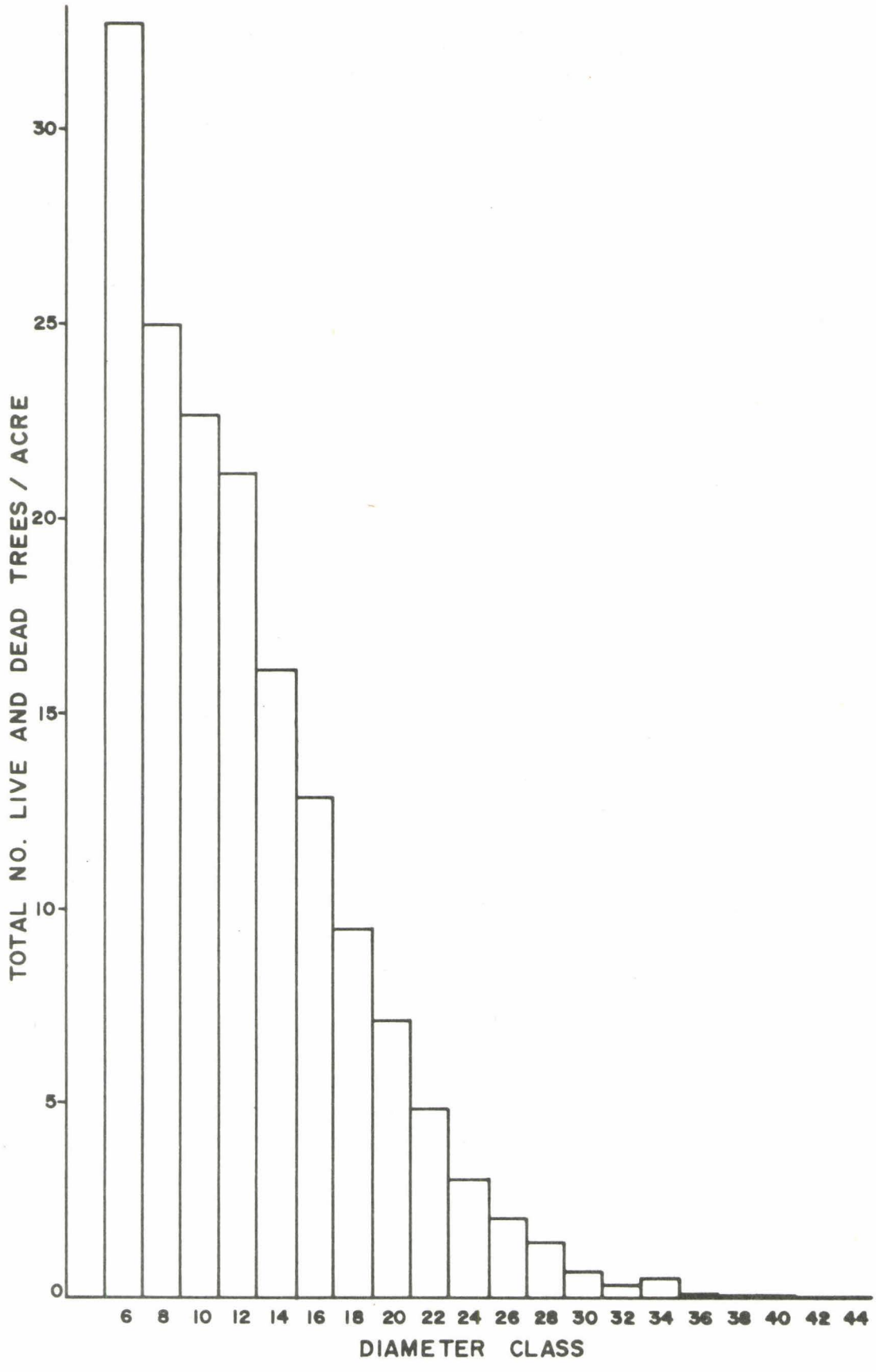


Fig. 3.— Total spruce trees / acre by diameter for the cruised area within Diamond, Ord, Paradise and Smith Creeks.

Table 3.--Spruce stand table for the cruised area within Diamond, Ord, Paradise, and Smith Creeks.

D.b.h. (2-in. classes)	No. Engelmann spruce trees/acre							
	Total stand		Infested in 1971		Infested prior to 1971		Total dead	
	Mean	Percentile	Mean	Percentile	Mean	Percentile	Mean	Percentile
6	32.67	20.38	.06	2.78	0.05	0.96	0.1	1.36
8	25.0	15.59	.1	4.63	.42	8.06	.52	7.08
10	22.68	14.14	.2	9.26	.42	8.06	.61	8.3
12	21.18	13.21	.31	14.35	.62	11.89	.93	12.66
14	16.13	10.06	.31	14.35	.46	8.82	.78	10.62
16	12.84	8.01	.3	13.89	.47	9.01	.77	10.48
18	9.48	5.91	.3	13.89	.58	11.12	.88	11.98
20	7.12	4.44	.18	8.33	.54	10.36	.72	9.8
22	4.88	3.04	.14	6.48	.45	8.63	.6	8.17
24	3.09	1.93	.12	5.56	.36	6.9	.49	6.67
26	2.04	1.27	.07	3.24	.27	5.18	.33	4.49
28	1.45	0.9	.02	0.92	.3	5.75	.32	4.36
30	0.7	.44	.02	.92	.12	2.3	.13	1.77
32	.34	.22	.02	.92	.07	1.34	.08	1.09
34	.52	.32	.005	.23	.04	.77	.04	.54
36	.09	.06	.003	.14	.02	.38	.02	.27
38	.06	.04	.001	.05	.01	.002	.01	.14
40	.06	.04	.001	.05	.01	.002	.01	.14
42	.01	.01	.001	.05	.004	.001	.004	.05
44	.01	.01	.001	.05	0	0	.001	.01

Total merchantable volume of spruce (d.b.h. $\geq$ 9 in.) before beetle losses varied from a low of 20,850 bd. ft./acre in Diamond Creek to a high of 34,235 bd. ft./acre in Paradise Creek (Table 4).

Table 4.--Merchantable spruce resource and losses due to the spruce beetle.

	Merchantable spruce volume (bd. ft./acre)				
		Spruce beetle loss			
Drainage	Stand total	1971	Pre-1971	Total	%
Diamond	20,850	261	2,003	2,264	10.86
Ord	27,052	539	1,869	2,408	8.9
Paradise	34,235	1,281	3,026	4,307	12.58
Smith	22,454	719	2,550	3,269	14.56

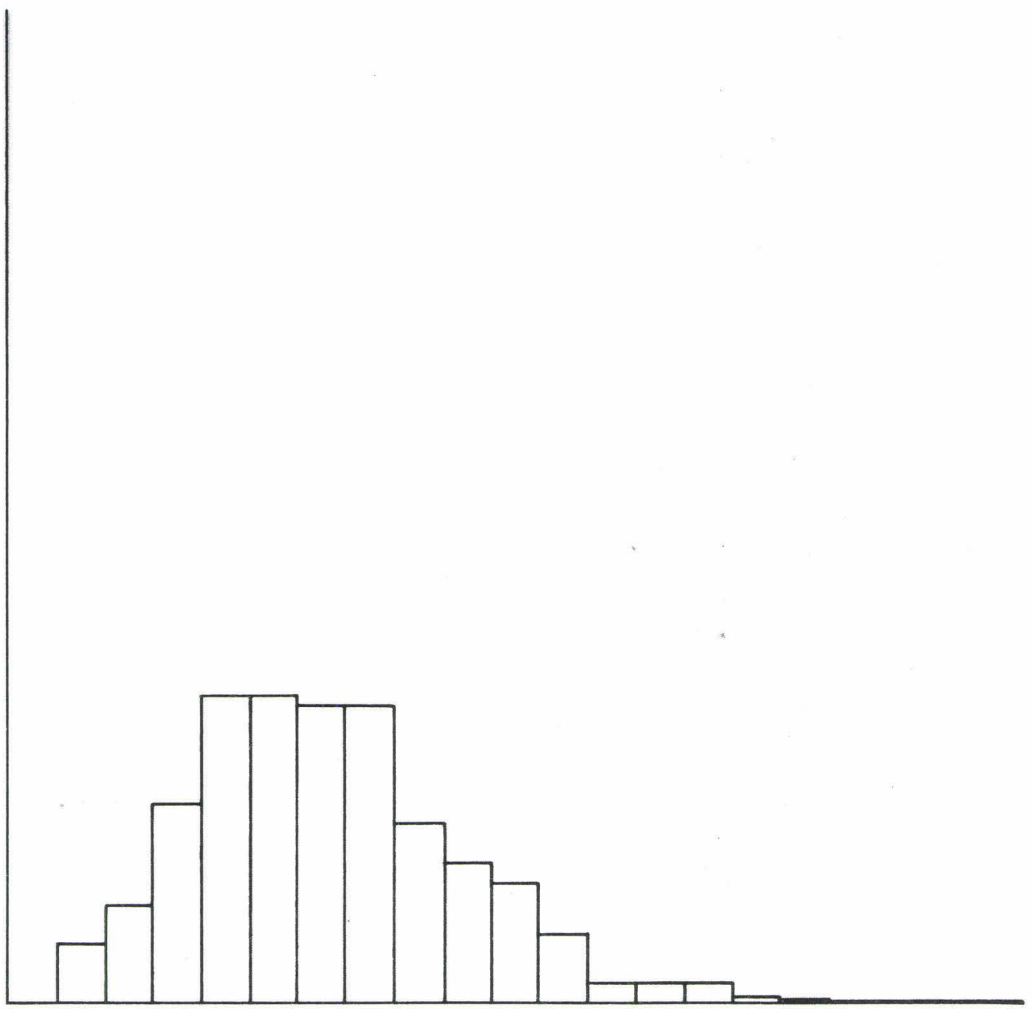
Impact on Timber Resource. The largest losses occurred in Paradise Creek where there was a reduction of 9.46 trees/acre (5.12% of the total spruce stems) (Table 1). The b.a./acre had been reduced by 19.26 or 9.94% (Table 2). Volume loss was 1,281 bd. ft./acre or 12.58% of the total merchantable resource (Table 4).

The highest percentage loss of the spruce resource was in Smith Creek. Total tree loss was 8.7 trees/acre, which was a reduction of 6.11% (Table 1). The b.a./acre reduction was 15.1 or 10.36% (Table 2). The merchantable volume loss was 3,269 bd. ft./acre, which was a 14.56% loss (Table 4).

The impact in Diamond and Ord Creeks was much less. Total tree losses in Diamond Creek was 3.66 trees/acre (3.76% dead) and 4.85 trees/acre (3.45% dead) in Ord Creek (Table 1). Diamond and Ord Creeks had a reduction in b.a./acre of 9.04 (7.69% dead) and 11.3 (6.85% dead), respectively (Table 2). The total merchantable volume loss in Diamond Creek was 2,264 bd. ft./acre (10.86%) and 2,408 bd. ft./acre (8.9%) in Ord Creek.

Figure 4 characterizes tree loss by diameter for 1971 and pre-1971. Mortality was highest in the intermediate diameter classes. The 8- to 22-inch diameter classes accounted for 79% of the total mortality (Table 3). The 12-inch diameter class was highest with 12.66% total tree mortality. Tree losses in 1971 were centered even more in the 12- to 18-inch diameter classes.

Although tree loss was dominant in the intermediate diameter classes, the loss of large trees (d.b.h. $\geq$ 23 in.) was of significance (Table 3). The large trees occupied only 5.24% of the stand, yet they



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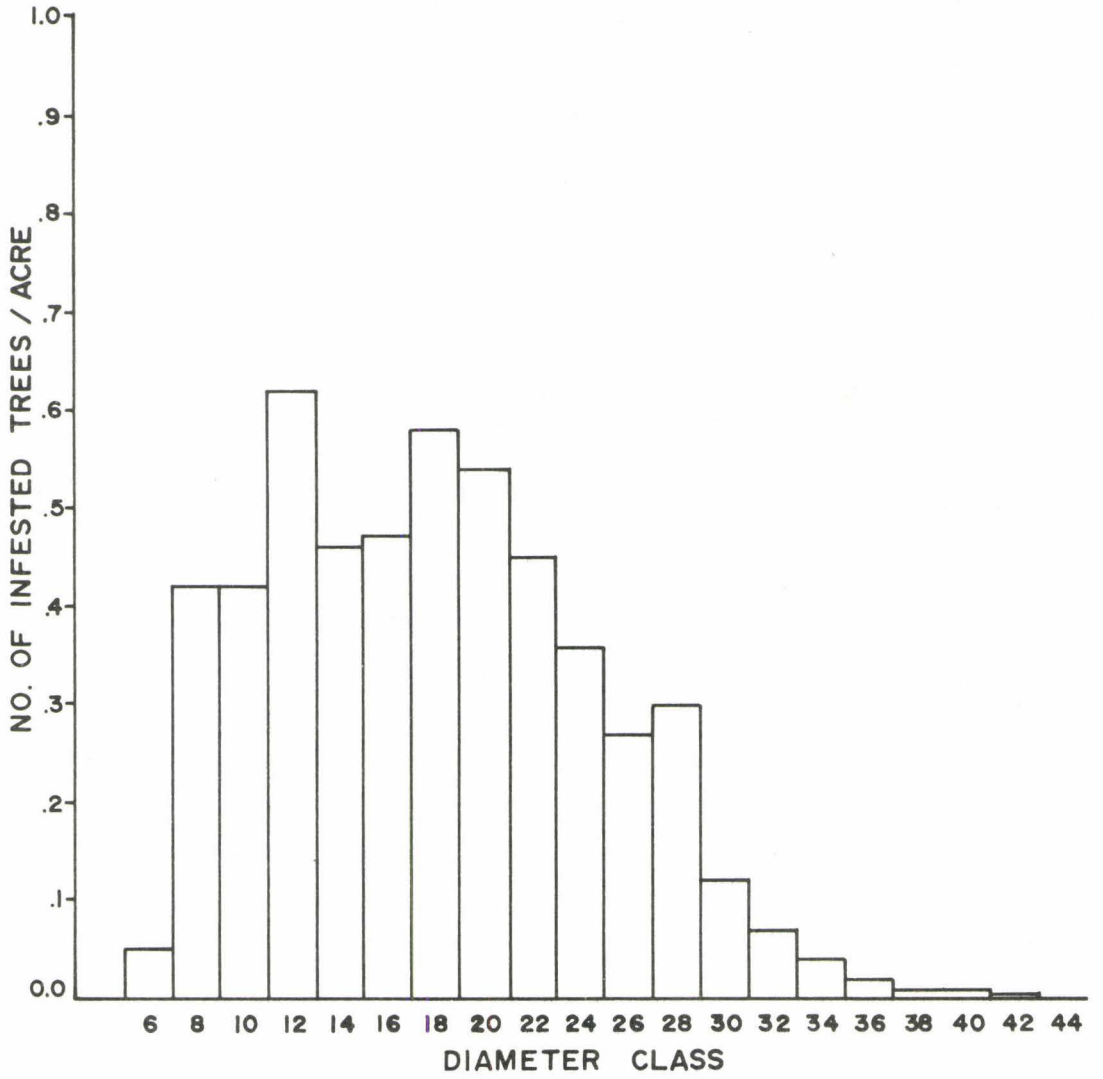

Fig. 4 .— Spruce beetle mortality prior to 1971

accounted for 22.62% of the total loss prior to 1971 and 12.13% in 1971. The total loss of the larger trees was 19.54%.

Infestation Level. The most active area during 1971 was within Paradise Creek, where a total of 4.16 trees/acre were infested last summer (Table 1). In 1970, there were 5.37 infested trees/acre and 4.15 in 1969. Tree loss in 1971 in the remaining three drainages varied from 0.7 trees/acre in Diamond Creek to 1.98 trees/acre in Ord Creek. These three drainages showed a substantial decrease from last year.

Reservation Creek. There was very little beetle activity in the area adjacent to the clearcut blocks in Reservation Creek. Only 0.24 trees/acre were infested in 1971 (Table 1).

Infestation Trend.--Bark sample data from Diamond, Ord, Paradise, and Smith Creek drainages indicated that the number of trees which will be infested during the summer of 1972 will decrease or remain static (Table 5). Tree loss in 1972 will continue to decrease in Diamond and Ord Creek drainages. Tree loss in Smith Creek will remain static. The expected loss in Paradise Creek will remain the same or drop in 1972.

Table 5.--Number of adults and attack density in 6X6-in bark samples collected in September 1971 from trees which were attacked in 1970.

Drainage	No. samples	Mean	Minimum value	Maximum value	Standard deviation	Standard error of the mean	Coefficient of variation
			Total live adults/6X6-in. bark sample				
Diamond	22	0.6 ± .1[b]	0	4.4	1.2	0.26	184.72
Ord	24	.5 ± .5[b]	0	5.3	1.27	1.06	244.3
Paradise	24	2.3 ± 1.5[c]	0	12.8	3.49	.71	149.61
Smith	24	2.7 ± 2.3[a]	0	20.7	5.4	1.1	196.94

[a] Static population.
[b] Decreasing population.
[c] Static to decreasing population.

DISCUSSION

The interpretation of stand tables is subjective, in that no comparative information is available on stand tables and spruce beetle epidemics. The interpretation is further complicated by the fact that this infestation is at the southern boundary of the beetle and host type. This evaluation does give a better insight into the current stand conditions and timber losses. The evaluation also raises questions on stand structure that must be answered if we are to understand the beetle's potential impact on this spruce stand or any other problem area.

The beetle's impact on the timber resource was less than expected. There are $2\frac{1}{2}$ million spruce trees with a d.b.h. of 5 inches or more within the 14,965 cruised acres of Diamond, Ord, Paradise, and Smith Creek drainages, with a merchantable sawtimber resource of 382.9MBF. The spruce beetle had killed 4% of these trees, resulting in a merchantable volume loss of 46.5MBF or 12.2% of the merchantable volume within the cruised area. The loss in 1971 was 76,800 trees or 11MBF.

Tree losses were influenced by basal area. Smith and Paradise Creeks had the highest basal area and the largest trees, resulting in the highest losses. The lowest losses were in Diamond Creek, which had the lowest basal area and the smallest trees.

The cruise data have possibly contradicted our past evaluations which referred to the stand as being mature to overmature, and, therefore, highly susceptible to the spruce beetle. The high losses incurred during the Colorado spruce beetle epidemic during the 1940's and 1950's were reported to be caused by large, overmature and overstocked stands. Subsequently, spruce beetle outbreaks have had the connotation of what occurred in Colorado. Our past evaluations have referred to this as being the case for the Reservation spruce.

With this in mind, we presented the results of this evaluation to Robert R. Alexander, principle silviculturist, Rocky Mountain Forest and Range Experiment Station. Dr. Alexander, who has seen the Fort Apache spruce stands, felt that they varied greatly from those in Colorado, and that they also varied within the Reservation. Alexander's general "rule of thumb" for spruce b.a./acre was as follows: Light - less than 100 ft^2; medium - 100-200; and heavy - more than 200. Many of the Colorado stands were so overstocked that they had a b.a./acre of 300 plus. The spruce stocking on the Reservation ranged from 180 to 226 b.a./acre for all species.

The cruised spruce was surprisingly small, with 73.4% of all the spruce having a d.b.h. of 14.9 inches or less, and only 5.24% having a d.b.h. greater than 22.9 inches. These trees do not represent a typical overmature stand on good sites.

The larger trees, in proportion to their occurrence, incurred a higher percentage loss than the more numerous intermediate sized trees which suffered a higher loss in total numbers. Although the larger trees may be the preferred host, the spruce beetle was not as selective as previously thought. Forest Service entomologists in Region 4 have found this to also be the case with mountain pine beetle (D. ponderosae Hopk.) in the Grand Teton area of Wyoming (Klein et al. 1972). Klein and his co-workers reported that mortality in the various diameter classes was inversely proportional to their occurrence in the stand, and that the intermediate diameter classes were primarily responsible for maintaining the infestation. Whether or not the intermediate size spruce trees can maintain a spruce beetle population under a non-epidemic condition remains to be seen.

Site quality and tree vigor information is needed to determine what kind of stand we are working with and to what degree it is susceptible to the beetle.

In late October, high winds caused extensive spruce blowdown. Heavy raveling occurred around the clearcut blocks in Reservation, Becker, and Paradise Creeks. Scattered and concentrated blowdown occurred in all areas. What effect this will have on the present beetle population is presently speculative. Blowdown is a primary factor in most infestations and could provide the impetus for a population increase in 1974 (Massey and Wygant 1954).

At present, the beetle infestation has lost its epidemic proportions and has evidently run its course in Reservation Creek. Without the blowdown, the beetle generation that will fly in 1972 would have infested fewer standing trees than it did in 1970. The beetles should now infest the blowdown, resulting in a further decrease of standing hit trees in 1972. The blowdown population will not fly until 1974.

Many biological and environmental factors will influence beetle production in the blowdown. The blowdown that is exposed to the sun will be susceptible to high brood production only in 1972, while shaded material will also be susceptible during 1973. The spruce beetle cannot survive where the bark surface is exposed to direct sunlight.

If a high ips population attacks the blowdown, it will lower spruce beetle brood production because of interspecific competition. Ips flights occur before that of the spruce beetle, and their multi-generations per year result in more attacks and brood, which leaves less area for the spruce beetle. Ips survive where the bark is exposed to direct sunlight.

In declining infestations, similar to that on the Fort Apache, predation by woodpeckers is an important factor (Baldwin 1968). The woodpecker population has built up; therefore, the woodpeckers that remain will be forced to feed on the blowdown population. However, woodpeckers are not effective when down material is covered by snow.

RECOMMENDATIONS

Without the blowdown, our only recommendation would be basically the practice of sound spruce management, since all signs are for a downward population trend. The blowdown should be used to the land manager's benefit by utilizing it as trap trees. In doing so, the down spruce should not be removed until after August 15, 1972. If it is necessary to salvage down material before this date, the material in Reservation Creek could be removed because of the few infested standing trees.

A limited cruise should be made in the same drainages after the 1972 beetle flight. A cruise as extensive as conducted in 1971 will not be necessary in 1972. How limited the cruise should be will have to be determined by further analysis of the 1971 cruise data to determine the estimated minimum number of plots necessary for a statistically sound survey. As much of the blowdown as possible will have to be located and sampled in order to determine its effect on the beetle population. The 1972 work can be financed from our funds.

Should the 1972 evaluation of down material indicate a resurgence of the beetle population, suppressive action before July of 1974 may be necessary.

The stand table data collected in 1971 have been recorded on magnetic tape and will be retained for further analysis. The use of this stand table data work and the ADP print-out maps should be explored in any proposed pest management system, should it become necessary.

The infestation should be followed to conclusion and a case history prepared, documenting the impact on all resources.

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A P P E N D I X E S

LIST OF APPENDIXES

Appendix		Page
1	Diamond Creek Engelmann spruce stand table	19
2	Diamond Creek non-host stand table	20
3	Statistical analysis for Engelmann spruce in Diamond Creek	21
4	Statistical analysis for non-host trees in Diamond Creek .	21
5	Ord Creek Engelmann spruce stand table	22
6	Ord Creek non-host stand table	23
7	Statistical analysis for Engelmann spruce in Ord Creek ...	24
8	Statistical analysis for non-host trees trees in Ord Creek	24
9	Paradise Creek Engelmann spruce stand table	25
10	Paradise Creek non-host stand table	26
11	Statistical analysis for Engelmann spruce in Paradise Creek	27
12	Statistical analysis for non-host trees in Paradise Creek	27
13	Smith Creek Engelmann spruce stand table	28
14	Smith Creek non-host stand table	29
15	Statistical analysis for Engelmann spruce in Smith Creek .	30
16	Statistical analysis for non-host trees in Smith Creek ...	30
17	Reservation Creek Engelmann spruce stand table	31
18	Reservation Creek non-host stand table	32
19	Statistical analysis for Engelmann spruce in Reservation Creek	33
20	Statistical analysis for non-host trees in Reservation Creek	33
21	Supplemental results for the 6X6-in. bark samples collected September 1971 from trees which were attacked in 1970	34
22	Results of 6X6-in. bark samples collected in September 1971 from Engelmann spruce which had been attacked by spruce beetles in 1970	35-38

Appendix 1.--Diamond Creek Engelmann spruce stand table.

D.b.h. (2 in. classes)	Number of Engelmann spruce trees/acre						
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	% dead	Total	Percentile
6	29.35	0	0	0	0	29.35	25.30
8	16.41	0.1	0.29	0.38	2.29	16.80	14.48
10	13.82	.06	.31	.37	2.60	14.20	12.23
12	12.92	.13	.38	.51	3.81	13.44	11.58
14	9.46	0	.25	.25	2.58	9.72	8.38
16	8.16	.12	.22	.34	3.96	8.49	7.32
18	6.18	.04	.49	.53	7.91	6.71	5.79
20	5.34	.08	.37	.44	7.69	5.79	4.99
22	3.74	.04	.34	.38	9.23	4.12	3.55
24	2.28	.08	.26	.34	13.01	2.62	2.26
26	1.49	.04	.32	.35	19.21	1.84	1.59
28	1.08	.01	.19	.20	15.34	1.28	1.10
30	0.66	0	.13	.13	16.52	0.78	0.68
32	0.29	.01	.06	.07	18.33	.36	.31
34	0.21	0	.03	.03	13.04	.24	.21
36	0.09	0	.01	.01	13.67	.10	.09
38	0.04	.004	.004	.01	18.18	.05	.04
40	0.07	0	.01	.01	9.52	.08	.07
42	0.01	0	0	0	0	.01	.01
44	0.02	0	0	0	0	.02	.01
Total	111.64	.70	3.66	4.36	3.76	115.99	100.0
Percent	96.24	.60	3.16	3.76			

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 2.--Diamond Creek non-host stand table.

D.b.h. (2 in. classes)	Number of non-host trees/acre				
	Douglas-fir	True fir	Aspen	Total	Percentile
6	1.36	20.47	11.43	33.26	35.5
8	0.48	12.28	8.73	21.49	22.94
10	.8	8.17	3.62	12.59	13.43
12	1.24	4.56	1.92	7.72	8.24
14	.97	3.73	1.32	6.02	6.42
16	.86	2.14	0.50	3.5	3.74
18	1.02	1.61	.44	3.07	3.28
20	.8	0.88	.18	1.86	1.98
22	.8	.58	.16	1.55	1.65
24	.56	.4	.05	1.01	1.08
26	.49	.12	.03	0.64	0.68
28	.27	.12	.02	.4	.43
30	.11	.05	0	.16	.18
32	.1	.04	0	.14	.15
34	.08	.01	.005	.1	.1
36	.05	.01	0	.06	.07
38	.05	.004	0	.06	.06
40	.04	.004	.004	.05	.05
42	.007	.003	0	.01	.01
44	.01	0	0	.01	.01
Total	10.12	55.19	28.42	93.73	100.0
Percent	10.79	58.88	30.32	100.0	

Appendix 3.--Statistical analysis for Engelmann spruce in Diamond Creek.

Statistical parameters	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	Total
Mean/acre	111.64	0.7	3.66	4.36	115.99
Standard deviation	117.44	4.21	10.19	11.56	117.85
Standard error	4.81	0.17	0.42	0.47	0.48
Coefficient of variation	105.2	603.34	274.4	265.44	101.6

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971

Appendix 4.--Statistical analysis for non-host trees in Diamond Creek.

Statistical parameters	Douglas-fir	True fir	Aspen	Total
Mean/acre	10.25	55.19	28.43	93.74
Standard deviation	26.42	82.26	109.92	134.37
Standard error	1.08	3.37	4.5	5.5
Coefficient of variation	257.67	149.05	386.69	143.35

Appendix 5.--Ord Creek Engelmann spruce stand table.

D.b.h. (2 in. classes)	Number of Engelmann spruce trees/acre						
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	% dead	Total	Percentile
6	36.65	0.11	0	0.11	0.3	36.76	18.59
8	34.0	.12	0.31	.43	1.26	34.44	17.41
10	31.69	.12	.28	.39	1.23	32.1	16.22
12	28.29	.33	.67	.99	3.39	29.29	14.81
14	19.93	.4	.81	1.22	5.76	21.15	10.69
16	14.02	.23	.67	.90	6.05	14.92	7.54
18	9.82	.23	.47	.7	6.65	10.52	5.32
20	6.52	.16	.49	.65	9.03	7.17	3.62
22	4.21	.12	.45	.58	12.05	4.78	2.42
24	2.37	.08	.28	.36	13.2	2.73	1.38
26	1.49	.03	.14	.17	10.31	1.67	0.84
28	0.89	0	.16	.16	14.96	1.05	.53
30	.42	.02	.05	.07	14.44	0.49	.25
32	.25	.004	.04	.04	14.75	.29	.15
34	.18	.01	.02	.03	12.99	.21	.11
36	.1	.003	.003	.01	5.92	.1	.05
38	.04	0	.01	.01	20.18	.06	.03
40	.03	0	.002	.002	8.32	.03	.02
42	.01	0	.004	.004	25.02	.02	.01
44	.01	.002	0	.002	16.86	.01	.01
Total	190.95	1.98	4.85	6.83	3.45	197.79	100.0
Percent	96.55	1.0	2.4	3.45			

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 6.--Ord Creek non-host stand table.

D.b.h. (2 in. classes)	Number of non-host trees/acre				
	Douglas-fir	True fir	Aspen	Total	Percentile
6	0.67	10.07	0.67	11.41	31.2
8	.44	5.35	.88	6.67	18.24
10	.77	3.22	1.13	5.12	13.99
12	.95	2.1	1.71	4.76	13.0
14	1.25	1.05	.92	3.22	8.22
16	.72	0.77	.58	2.07	5.68
18	.6	.45	.15	1.2	3.26
20	.49	.25	.1	0.83	2.31
22	.28	.12	.02	.42	1.16
24	.3	.06	.007	.37	1.01
26	.19	.02	.006	.22	0.6
28	.08	.02	0	.1	.28
30	.07	0	0	.07	.2
32	.04	.004	0	.04	.11
34	.01	0	0	.01	.03
36	.02	0	0	.02	.04
38	.01	0	0	.01	.02
40	.003	0	0	.003	.007
42	.002	0	0	.002	.006
44	.01	0	0	.01	.03
Total	6.91	23.49	6.18	36.58	100.0
Percent	18.88	64.19	16.93	100.0	

Appendix 7.--Statistical analysis for Engelmann spruce in Ord Creek.

Statistical parameters	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	Total
Mean/acre	62.08	0.24	4.8	5.04	67.11
Standard deviation	63.17	1.12	12.28	12.58	64.82
Standard error	8.16	0.14	1.58	1.62	8.37
Coefficient of variation	101.76	475.78	255.99	249.75	96.59

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 8.--Statistical analysis for non-host trees in Ord Creek.

Statistical parameters	Douglas-fir	True fir	Aspen	Total
Mean/acre	4.14	59.53	7.18	69.99
Standard deviation	105.78	77.89	15.99	80.54
Standard error	1.36	10.06	2.06	10.4
Coefficient of variation	255.6	130.84	222.58	115.07

Appendix 9.--Paradise Creek Engelmann spruce stand table.

D.b.h. (2 in. classes)	Number of Engelmann spruce trees/acre						
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	% dead	Total	Percentile
6	40.72	0.11	0	0.11	0.28	40.83	22.05
8	26.94	.19	0.26	.45	1.63	27.38	14.79
10	22.6	.4	.28	.69	2.96	23.29	12.58
12	21.13	.59	.36	.96	4.34	22.09	11.93
14	17.4	.58	.46	1.04	5.62	18.43	9.96
16	14.08	.57	.44	1.02	6.73	15.09	8.15
18	10.22	.69	.55	1.24	10.84	11.46	6.19
20	7.48	.34	.59	.94	11.1	8.42	4.55
22	5.19	.27	.55	.82	13.56	6.01	3.24
24	3.12	.18	.47	.66	17.14	3.83	2.07
26	2.49	.11	.37	.48	16.01	2.97	1.6
28	1.67	.05	.66	.72	29.94	2.39	1.29
30	0.66	.03	.13	.16	19.34	0.82	0.44
32	.34	.02	.1	.12	25.65	.45	.24
34	1.38	.003	.04	.05	3.2	1.43	.77
36	.08	.01	.02	.03	27.35	.10	.06
38	.06	0	.01	.01	14.79	.08	.04
40	.04	.003	.01	.01	22.61	.06	.03
42	.007	.002	0	.002	25.12	.01	.01
44	.02	.002	0	.002	12.5	.02	.01
Total	175.68	4.16	5.3	9.47	5.12	185.15	100.0
Percent	94.9	2.2	2.9	5.12			

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 10.--Paradise Creek non-host stand table.

D.b.h. (2 in. classes)	Number of non-host trees/acre				
	Douglas-fir	True fir	Aspen	Total	Percentile
6	1.14	9.58	7.87	18.59	34.11
8	0.64	5.65	7.89	14.18	26.13
10	.41	4.85	4.15	9.41	17.25
12	.43	2.85	1.57	4.85	8.89
14	.48	1.13	0.65	2.26	4.15
16	.58	0.59	.19	1.36	2.5
18	.48	.54	.19	1.21	2.23
20	.39	.23	.13	0.75	1.38
22	.26	.3	.05	.61	1.1
24	.3	.11	.01	.42	0.78
26	.26	.04	.006	.31	.56
28	.13	.01	.005	.14	.26
30	.09	.02	0	.11	.19
32	.05	.004	0	.05	.1
34	.05	.004	0	.05	.09
36	.04	.006	0	.05	.09
38	.03	.006	0	.04	.07
40	.03	.003	0	.03	.06
42	0	0	0	0	0
44	.008	0	0	.008	.02
Total	5.8	25.92	22.72	54.44	100.0
Percent	10.64	47.56	41.68	100.0	

Appendix 11.--Statistical analysis for Engelmann spruce in Paradise Creek.

Statistical parameters	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	Total
Mean/acre	175.68	4.16	5.31	9.47	185.15
Standard deviation	142.53	15.05	17.93	26.17	143.59
Standard error	4.77	0.5	0.6	0.88	4.8
Coefficient of variation	81.13	361.96	337.41	276.28	77.56

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 12.--Statistical analysis for non-host trees in Paradise Creek.

Statistical parameters	Douglas-fir	True fir	Aspen	Total
Mean/acre	5.8	25.92	22.72	54.5
Standard deviation	21.35	59.4	106.23	126.8
Standard error	0.71	1.99	3.55	4.24
Coefficient of variation	368.3	229.13	467.56	232.63

Appendix 13.--Smith Creek Engelmann spruce stand table.

D.b.h. (2 in. classes)	Number of Engelmann spruce trees/acre						
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	% dead	Total	Percentile
6	23.54	0	0.19	0.19	0.78	23.73	16.67
8	20.54	0	.83	.83	3.90	21.38	15.0
10	20.15	0.2	.80	1.00	4.73	21.15	14.85
12	18.63	.18	1.07	1.25	6.29	19.88	13.96
14	14.60	.27	.34	.61	4.03	15.22	10.68
16	12.07	.26	.55	.81	6.27	12.88	9.04
18	8.18	.25	.81	1.05	11.38	9.23	6.48
20	6.26	.15	.70	.85	11.97	7.11	4.99
22	4.01	.14	.47	.61	13.13	4.62	3.24
24	2.59	.16	.43	.59	18.54	3.18	2.24
26	1.37	.10	.24	.33	19.19	1.7	1.19
28	0.88	.03	.17	.20	18.26	1.07	0.75
30	.50	.02	.16	.17	25.24	0.68	.47
32	.17	.02	.07	.09	35.0	.26	.18
34	.16	.006	.05	.05	25.0	.21	.15
36	.04	0	.03	.03	46.14	.07	.05
38	.02	0	.01	.009	28.6	.03	.02
40	.02	0	.02	.02	54.53	.05	.03
42	.004	0	.01	.008	66.67	.01	.008
44	0	0	0	0	0	0	0
Total	133.74	1.77	6.93	8.7	6.1	142.44	100.0
Percent	93.9	1.2		6.1	4.9		

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 14.--Smith Creek non-host stand table.

D.b.h. (2 in. classes)	Number of non-host trees/acre				
	Douglas-fir	True fir	Aspen	Total	Percentile
6	2.97	12.06	10.76	25.79	29.43
8	1.67	10.01	9.08	20.76	23.94
10	2.47	5.61	6.34	14.42	16.46
12	1.94	2.92	3.57	8.43	9.63
14	2.11	2.14	1.7	5.95	6.81
16	1.98	0.99	0.99	3.96	4.53
18	1.46	.72	0.6	2.78	3.18
20	1.17	.45	0.32	1.94	2.21
22	0.79	.22	0.03	1.04	1.18
24	0.76	.07	0.02	0.85	0.98
26	0.49	.02	0	.51	.59
28	0.34	.02	0	.36	.41
30	0.23	0	0	.23	.26
32	0.14	0	0	.14	.16
34	0.09	0	0	.09	.1
36	0.04	.005	0	.04	.05
38	0.03	0	0	.03	.03
40	0.04	0	0	.04	.04
42	0.004	0	0	.004	.004
44	0.007	0	0	.007	.008
Total	18.73	35.25	33.42	87.37	100.0
Percent	21.39	40.23	38.14		

Appendix 15.--Statistical analysis for Engelmann spruce in Smith Creek.

Statistical parameters	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	Total
Mean/acre	133.74	1.77	6.93	8.7	142.44
Standard deviation	109.05	7.78	17.21	20.8	112.55
Standard error	4.65	0.33	0.73	0.89	4.8
Coefficient of variation	81.54	439.28	248.39	239.12	79.02

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 16.--Statistical analysis for non-host trees in Smith Creek.

Statistical parameters	Douglas-fir	True fir	Aspen	Total
Mean/acre	18.19	35.25	33.42	87.63
Standard deviation	52.52	66.4	118.78	142.51
Standard error	2.24	2.83	5.07	6.08
Coefficient of variation	279.53	188.34	355.43	162.62

Appendix 17.--Reservation Creek Engelmann spruce stand table.

D.b.h. (2 in. classes)	Number of Engelmann spruce trees/acre						
	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	% dead	Total	Percentile
6	17.35	0	0	0	0	17.35	25.84
8	7.96	0	0	0	0	7.96	11.86
10	5.5	0	0.44	0.44	7.35	5.94	8.85
12	14.14	0	.3	.3	2.1	14.44	21.52
14	4.27	0	.4	.4	8.62	4.67	6.96
16	4.75	0	.85	.85	15.22	5.6	8.35
18	2.76	0	.5	.5	15.24	3.26	4.85
20	1.84	0.7	.89	.96	34.34	2.8	4.17
22	1.8	.12	.68	.8	30.96	2.61	3.88
24	1.05	.05	.36	.41	28.0	1.46	2.17
26	0.18	0	.19	.19	51.4	0.37	0.54
28	.12	0	.11	.11	47.72	.23	.34
30	.15	0	0	0	0	.15	.22
32	.13	0	0	0	0	.13	.2
34	0	0	.05	.05	100.0	.05	.08
36	.09	0	0	0	0	.09	.14
38	0	0	.02	.02	100.0	.02	.03
40	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0
Total	62.08	0.24	4.8	5.04	7.5	67.11	100.0
Percent	92.5	.35	7.15	7.5			

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 18.--Reservation Creek non-host stand table.

D.b.h. (2 in. classes)	Number of non-host trees/acre				
	Douglas-fir	True fir	Aspen	Total	Percentile
6	0	20.37	0	20.37	29.11
8	0	12.41	0	12.41	17.74
10	0	11.0	1.83	12.83	18.34
12	9.85	6.37	1.27	8.49	12.13
14	.62	3.74	1.56	5.92	8.46
16	.24	2.15	0.72	3.1	4.43
18	.38	1.13	.38	1.89	2.7
20	.31	1.22	1.22	2.75	3.93
22	0	.38	.13	0.5	0.72
24	.42	.64	0	1.06	1.52
26	.09	0	0	.09	.13
28	.08	.08	.08	.23	.33
30	.14	0	0	.14	.19
32	.06	0	0	.06	.08
34	.05	0	0	.05	.08
36	0	.04	0	.04	.06
38	.04	0	0	.04	.06
40	0	0	0	0	0
42	0	0	0	0	0
44	0	0	0	0	0
Total	3.27	59.53	7.19	69.99	100.0
Percent	4.68	85.06	10.27	100.0	

Appendix 19.--Statistical analysis for Engelmann spruce in Reservation Creek.

Statistical parameters	Live	'71 I/T[a]	Pre '71 I/T[b]	Total dead	Total
Mean/acre	62.08	0.24	4.8	5.04	67.11
Standard deviation	63.17	1.12	12.28	12.58	64.82
Standard error	8.16	.14	1.58	1.62	8.37
Coefficient of variation	101.76	475.78	255.99	249.75	96.59

[a] Trees infested with spruce beetles in 1971.

[b] Trees infested with spruce beetles prior to 1971.

Appendix 20.--Statistical analysis for non-host trees in Reservation Creek.

Statistical parameters	Douglas-fir	True fir	Aspen	Total
Mean/acre	4.14	59.53	7.19	69.99
Standard deviation	10.58	77.89	15.99	80.54
Standard error	1.36	10.06	2.06	10.4
Coefficient of variation	255.6	130.84	222.58	115.07

Appendix 21.--Supplemental results for the 6X6-in. bark samples collected September 1971 from trees which were attacked in 1970.

Drainage	No. samples	Mean	Minimum value	Maximum value	Standard deviation	Standard error of the mean	Coefficient of variation
			Total dead adults/6X6-in. bark sample				
Diamond	22	1.3 ± .5	0	4.42	1.14	0.24	86.33
Ord	24	1.0 ± .7	0	6.35	1.65	.34	163.85
Paradise	24	1.4 ± .8	0	7.36	1.82	.37	125.88
Smith	24	1.5 ± .6	0	5.6	1.43	.29	93.94
			Total live larvae/6X6-in. bark sample				
Diamond	22	0.1 ± .1	0	0.66	0.19	0.04	323.78
Ord	24	.2 ± .3	0	3.79	.78	.16	429.72
Paradise	24	.1 ± .2	0	2.04	.41	.08	489.9
Smith	24	.7 ± 1.2	0	13.6	2.8	.57	423.48
			Total dead larvae/6X6-in. bark sample				
Diamond	22	0.6 ± .4	0	3.53	0.91	0.19	170.56
Ord	24	2.0 ± 1.5	0	14.09	3.51	.72	177.03
Paradise	24	1.7 ± 1.0	0	8.43	2.3	.47	135.32
Smith	24	.5 ± .4	0	4.8	1.08	.22	205.05
			Total inches of egg gallery/6X6-in. bark sample				
Diamond	22	8.3 ± 1.9	0	17.1	4.25	0.91	50.99
Ord	24	6.2 ± 1.3	0	15.8	4.33	.88	69.65
Paradise	24	7.4 ± 1.9	0.8	16.4	4.5	.91	60.68
Smith	24	9.8 ± 1.9	2.3	19.4	4.48	.92	45.92
			Total attacks/6X6-in. bark sample				
Diamond	22	1.0 ± 1.72	0	3.9	0.95	0.2	92.07
Ord	24	1.3 ± 1.6	0	3.8	.9	.88	70.83
Paradise	24	1.0 ± 1.1	0	2.6	.82	.91	80.56
Smith	24	1.1 ± 1.3	0	3.1	1.03	.21	89.99

Appendix 22.--Results of 6X6-in. bark samples collected in September 1971 from Engelmann spruce which had been attacked by spruce beetles in 1970.

Drainage	Tree No.	D.b.h.	Side sampled	Sample size (ft.^{2})	Totals/0.25 ft.^{2} of bark area					
					No. attacks	Egg gallery length (in.)	Larvae		Adults	
							Live	Dead	Live	Dead
Diamond	1	22.0	N	0.44	0	5.6	0	0	0.6	0
			S	.35	0.7	4.9	0	3.5	0	3.5
	2	20.5	N	.40	2.5	12.0	0	1.2	1.9	1.2
			S	.44	.6	3.9	0	0	0	0
	6	21.0	N	.45	1.1	10.0	0	0.6	0	0.6
			S	.45	.5	3.6	0	.5	0	.5
	7	18.0	N	.38	1.3	8.0	0	2.0	0	2.0
			S	.38	1.9	13.6	0	1.9	0	1.9
	8	23.5	N	.41	1.8	12.3	0	.6	0	.6
			S	.40	.6	8.7	0	0	0	1.9
	9	16.0	N	.39	1.9	11.6	0	0	0	.6
			S	.38	3.9	17.1	0.6	.6	0	1.3
	10	22.0	N	.40	.6	8.1	.6	.6	1.2	1.9
			S	.39	.6	8.2	0	0	4.4	1.9
	11	21.5	N	.40	1.3	13.6	0	0	3.2	4.4
			S	.39	0.6	9.0	0	0	0	0
	12	16.0	N	.41	1.2	13.2	0	0	0	1.2
			S	.39	.6	6.3	0	0	0	.6
	13	26.0	N	.44	0	3.1	0	0	0	0
			S	.49	0	6.4	0	0	0	1.0
	14	25.5	N	.40	.6	4.3	0	0	1.8	1.2
			S	.40	0	0	0	0	1.2	2.5

Appendix 22 (Continued)

Drainage	Tree No.	D.b.h.	Side sampled	Sample size (ft.^{2})	Totals/0.25 ft.^{2} of bark area					
					No. attacks	Egg gallery length (in.)	Larvae		Adults	
							Live	Dead	Live	Dead
Ord	1	19.0	N	0.42	1.2	7.8	0	1.2	0	0
			S	.41	1.2	4.6	0	1.8	0	0
	2	18.0	N	.39	1.9	8.7	0	10.3	0	0
			S	.44	0.6	4.6	0	2.3	0.61	0
	3	14.0	N	.34	Pitchout	0	0	0	0	0
			S	.41	1.8	8.0	0	0	0	1.2
	4	22.5	N	.41	1.2	4.0	0	3.1	0	0
			S	.52	0	0	0	0	0	0
	5	12.5	N	.42	1.8	9.6	0	3.0	1.5	0
			S	.40	1.8	6.5	0	0	0	0
	6	21.0	N	.33	.8	12.0	0	0	5.31	2.2
			S	.39	.6	1.9	0	0	0	0
	7	22.0	N	.38	1.3	9.6	0	2.0	0	0
			S	.46	2.2	9.5	3.8	1.6	0	1.1
	8	17.0	N	.47	1.1	4.5	0	5.9	0	1.6
			S	.39	1.3	4.5	0	0	2.74	1.3
	9	22.0	N	.39	0	0	0	0.6	0	0.6
			S	.46	1.1	9.3	0.5	1.6	0	1.1
	10	20.0	N	.44	0	0	0	0	2.35	0
			S	.47	1.0	5.8	0	0	0	2.1
	11	20.0	N	.42	1.2	2.4	0	0	0	.6
			S	.39	1.9	7.0	0	14.1	0	.6
	12	18.0	N	.35	2.8	13.0	0	0	0	6.4
			S	.33	3.8	15.8	0	0	0	5.2

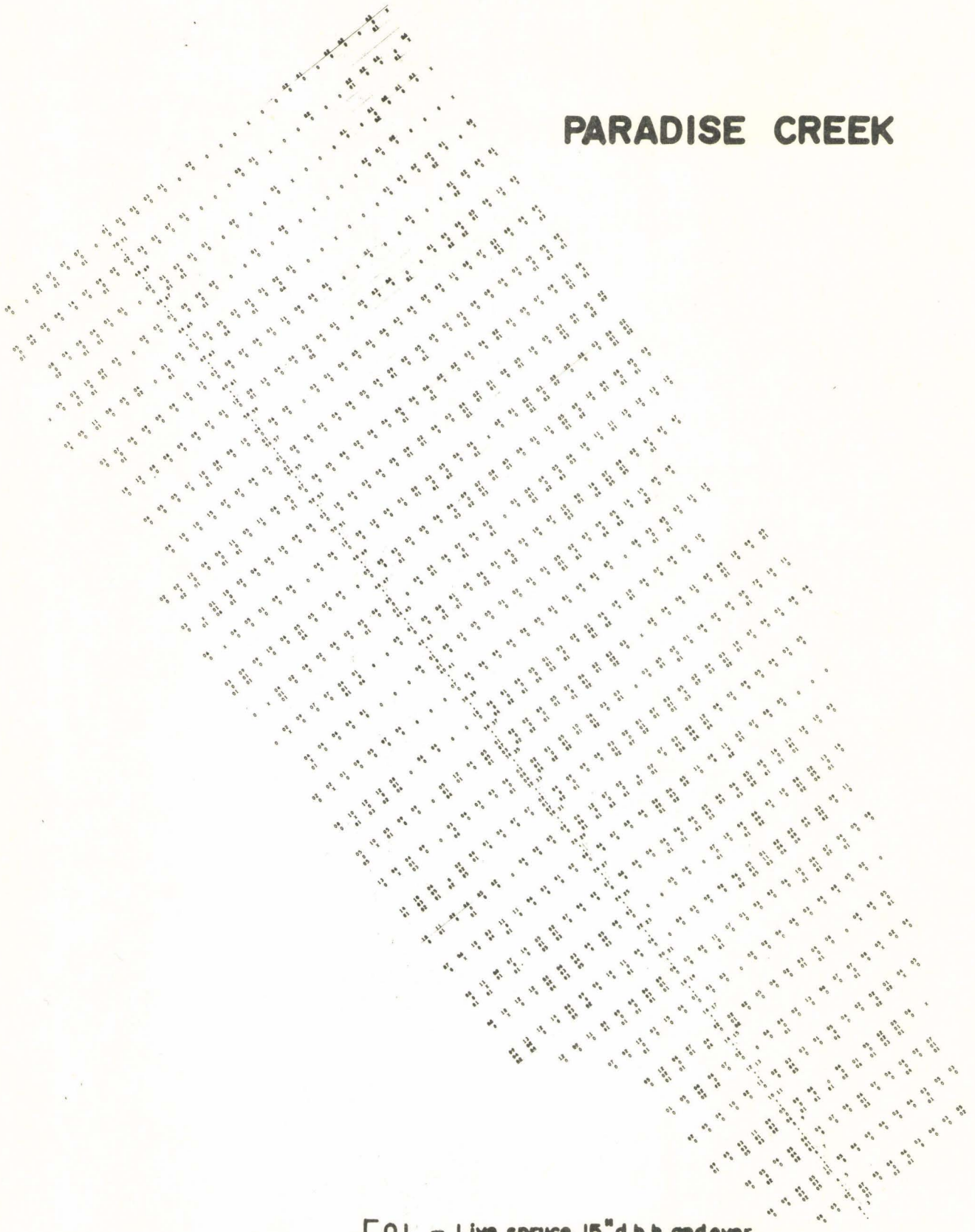
Appendix 22 (Continued)

Drainage	Tree No.	D.b.h.	Side sampled	Sample size (ft.^{2})	Totals/0.25 ft.^{2} of bark area					
					No. attacks	Egg gallery length (in.)	Larvae		Adults	
							Live	Dead	Live	Dead
Paradise	1	20	N	0.30	2.5	16.4	0	0	2.5	5.9
			S	.29	0.8	15.4	0	2.6	12.8	2.6
	2	22	N	.41	1.2	6.0	0	1.8	0	1.2
			S	.38	.7	5.3	0	3.3	0	0
	3	23	N	.38	2.0	16.0	0	2.0	2.7	1.3
			S	.36	0	4.8	0	0.7	0	0.7
	4	16.5	N	.35	0	2.1	0	.7	0	.7
			S	.40	.6	5.0	0	.6	1.9	0
	5	20.0	N	.31	0	0.8	0	1.6	0.8	.8
			S	.30	.8	10.6	0	0	0	7.4
	6	19.0	N	.29	2.6	13.7	0	2.6	3.4	0
			S	.35	0	10.7	0	.7	12.1	2.1
	7	22.0	N	.46	0	1.6	0	0	4.4	1.6
			S	.31	1.6	9.2	0	.8	0	.8
	8	23.0	N	.39	1.3	3.8	0	0	.6	.6
			S	.39	1.3	5.4	0	0	.6	1.9
	9	20.0	N	.36	1.4	8.1	0	8.4	0	0
			S	.36	1.4	4.1	0	1.4	0	.7
	10	23.0	N	.49	.5	6.6	2.0	4.6	5.1	0
			S	.35	.7	2.8	0	0	3.6	0
	11	19.0	N	.39	1.3	9	0	1.3	2.6	0
			S	.36	0	6.6	0	7.6	0	2.1
	12	18.0	N	.31	2.4	5.6	0	0	1.6	2.4
			S	.41	1.2	7.3	0	0	1.2	1.8

Appendix 22 (Continued)

Drainage	Tree No.	D.b.h.	Side sampled	Sample size (ft.^{2})	Totals/0.25 ft.^{2} of bark area					
					No. attacks	Egg gallery length (in.)	Larvae		Adults	
							Live	Dead	Live	Dead
Smith	1	29.0	N	0.31	0.8	5.6	0	0	20.7	0.8
			S	.40	1.9	11.4	0	0	3.2	1.9
	2	20.0	N	.47	0	7.5	0	0	0	2.1
			S	.44	1.7	7.9	0	1.7	0	0.6
	3	28.0	N	.37	.7	12.1	0	0	0	0.7
			S	.31	0	12.8	0	0.8	7.2	3.2
	4	29.0	N	.45	2.2	11.7	2.2	1.7	3.9	2.2
			S	.38	.7	4.6	0	0	1.3	0
	5	31.0	N	.36	2.8	10.4	0	.7	5.5	1.4
			S	.41	3.1	16.6	0	0	17.2	0
	6	40.0	N	.44	.6	6.8	0	1.7	4.0	0
			S	.44	0	2.3	0	0	3.4	0
	7	26.0	N	.31	2.4	17.6	13.6	0	0.8	0
			S	.33	0	1.9	0	0	0	0
	8	18.0	N	.27	1.9	10.3	0	0	0	0
			S	.27	.9	14.5	0	0	0	0
	9	20.0	N	.35	2.9	19.4	0	0	0	0
			S	.41	0	7.3	0	0	0	0
	10	27.0	N	.31	1.6	12.8	0	0	.8	0
			S	.40	.6	7.4	0	0	0	0
	11	22.0	N	.43	1.2	6.4	0	.6	0	0
			S	.31	1.6	9.6	0	4.8	0	0
	12	26.0	N	.29	0	10.3	0	0	0	0
			S	.31	0	7.2	0	0	0	0

PARADISE CREEK



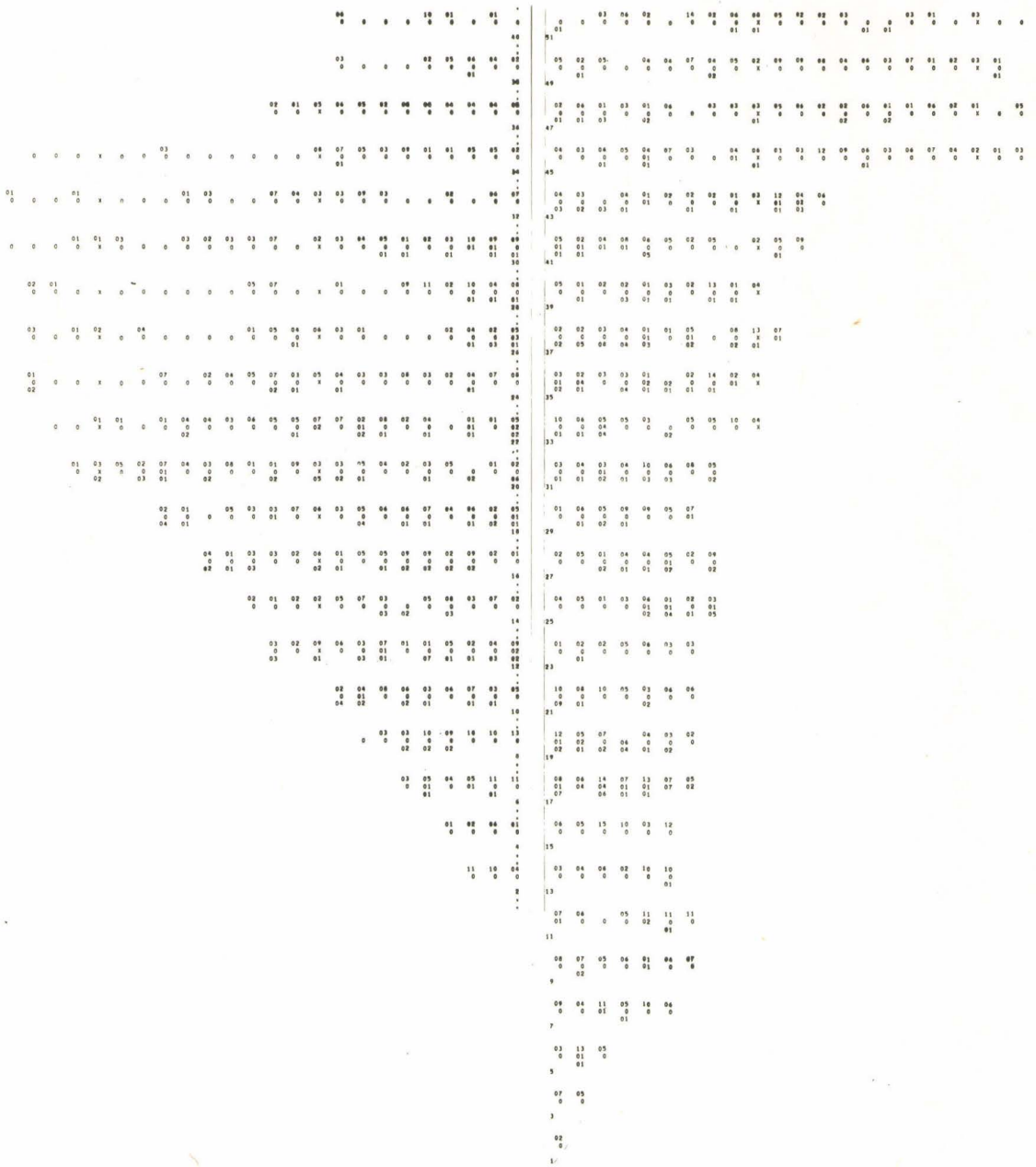
LEGEND:

Cruise Line
- 01 – Live spruce 15" d.b.h. and over
- 04 – Trees killed in 1971
- 02 – Trees killed prior to 1971

LEGEND: Cruise Line

- 01 – Live spruce 15" d.b.h. and over
- 04 – Trees killed in 1971
- 02 – Trees killed prior to 1971

SMITH CREEK



LEGEND:

Cruise Line
- 01 – Live spruce 15" d.b.h. and over
- 04 – Trees killed in 1971
- 02 – Trees killed prior to 1971

POPULATION SAMPLING SITES

ONE MILE

SMITH

BECKER

PARADISE

ORD

WEST FORK

DIAMOND

RESERVATION

BONITO